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April 12, 2021

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RE: Manley v. FCA US, LLC

Dear Mr. Spezia,

Pursuant to your request, I have reviewed information related to the Manley v. FCA case, which involves a February 16, 2017, alleged unintended acceleration of a 2011 Jeep Grand Cherokee with VIN 1J4RR6GT9BC620745 ("subject vehicle"). I have been asked to determine if the engine control electronics, including electronic throttle control ("ETC") and other related components and systems on the subject vehicle performed as designed prior to and during the incident. To evaluate the facts and circumstances surrounding this incident and to support my conclusions, I have inspected and tested the subject vehicle, reviewed photographs and test results from an exemplar vehicle, analyzed engineering and service documents, reviewed crash scene photographs, police and fire reports, vehicle records, and other relevant materials. I have applied scientific methodology and electrical engineering principles in my analysis. Appendix 1 contains a list of materials I have reviewed.

Qualifications

I hold a Ph.D. in Electrical Engineering and am a Principal Engineer at Carr Engineering, Inc., an engineering consulting firm. I am a licensed professional engineer in the following states: New York, Virginia, Arkansas, and Michigan. My areas of expertise include the analysis, design, and validation of electrical and electronic components and systems, including those used in automotive powertrain (engine and transmission) and airbag control systems. I have also taken professional development courses on accident reconstruction, biomechanics, frontal impact airbag systems, and side impact airbag systems. The conclusions presented in this report are made to a reasonable degree of scientific certainty based on my education, training, work performed in this case, and professional experience related to electrical and electronic systems. My curriculum vitae and four year testimony history are provided in Appendix 2 to this report.

Background

On February 16, 2017, Mr. Paul Manley was driving his 2011 Jeep Grand Cherokee, VIN 1J4RR6GT9BC620745, with Mr. Harold Manley in the front passenger seat. Per the Texas Peace Officer's Crash Report, Manley's vehicle was traveling north on SH 121 behind another vehicle. When the vehicle in front of Manley's vehicle slowed for an upcoming turn, Manley's vehicle struck the turning vehicle from behind. Manley's vehicle veered to the right shoulder of the roadway, accelerated, crossed Old Ector Rd, struck a stop sign, struck an embankment and went airborne flipping end over end in the median for approximately 318 feet.

Plaintiff's expert, Michael A. Stichter, states in his report that "the data contained in the CDR image of the airbag control module is consistent with a failure of the throttle control system outside of the control of the driver."

The subject vehicle's Carfax, based on VIN 1J4RR6GT9BC620745, shows a listing of standard maintenance performed on the vehicle. Further investigation into the vehicle history shows that all of the applicable recalls, four in total and none of which pertained to the throttle control system, were completed on the vehicle prior to the subject crash. The recalls were for the following:

- Loss of Power Brake Assist, dated April 1, 2014
- Vanity Lamp Short May Result in Fire, dated July 2, 2014
- Fuel Pump Relay May Fail Resulting in Stall, dated September 4, 2014
- Vanity Lamp Short May Result in Fire, dated December 28, 2015.

At mileages 37,053 and 46,957, services were completed that included a throttle body service. There was no indication of any parts being replaced. Typical throttle body service involves the cleaning of the throttle body with a special cleaning solution and removing carbon deposits from the throttle valve.

2011 Jeep Grand Cherokee Electronic Throttle Control System

Like most vehicles produced in the model year 2011 time frame, the subject Jeep Grand Cherokee is equipped with an Electronic Throttle Control ("ETC") system, which controls the throttle valve. In this system the accelerator pedal is not physically connected to the throttle valve as in mechanical throttle systems. Rather, the driver-commanded Accelerator Pedal Position Sensors ("APPS") are hardwired to the powertrain control module ("PCM"), which calculates a target throttle valve position and controls the throttle valve position through a control signal to the throttle body motor. The APPS signals do not travel through the Totally Integrated Power Module ("TIPM"). ETC provides a number of advantages over conventional cable systems including more precise control of airflow leading to lower emissions and better fuel economy, reduced maintenance due to component packaging advantages and fewer moving parts/mechanical interconnections, and the ability to implement more responsive and effective powertrain-dependent vehicle features such as electronic stability control.

The APPS is made up of two independent linear potentiometers that receive 5 VDC power and ground from the PCM. These sensors provide continuous voltage signals proportional to the angle, or position of the accelerator pedal. The APPS signals are translated (along with data from other

sensors including manifold absolute pressure, engine temperature, crankshaft position, engine RPM, brake switch status, as well as powertrain diagnostic information) to place the throttle plate to a pre-determined position. The throttle body is located in front of the intake manifold. The core function of the throttle body is to control the amount of air flow into the engine. The amount of air that is allowed inside is proportional to how far the driver has pressed the accelerator pedal. Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors.

If the driver presses down on the accelerator pedal, the throttle position motor receives a control signal that correlates to the driver's demand for power. Simultaneously, the throttle position sensors ("TPS") provide position data used by the PCM to monitor the actual throttle valve position. With continuous throttle and pedal position updates, the PCM determines how much fuel to inject into the engine cylinders and the correct spark plug firing time for each cylinder. With both the proper amount of air and fuel sent to the engine cylinders, the engine performs smoothly. Figure 1 shows a diagram of the ETC system.

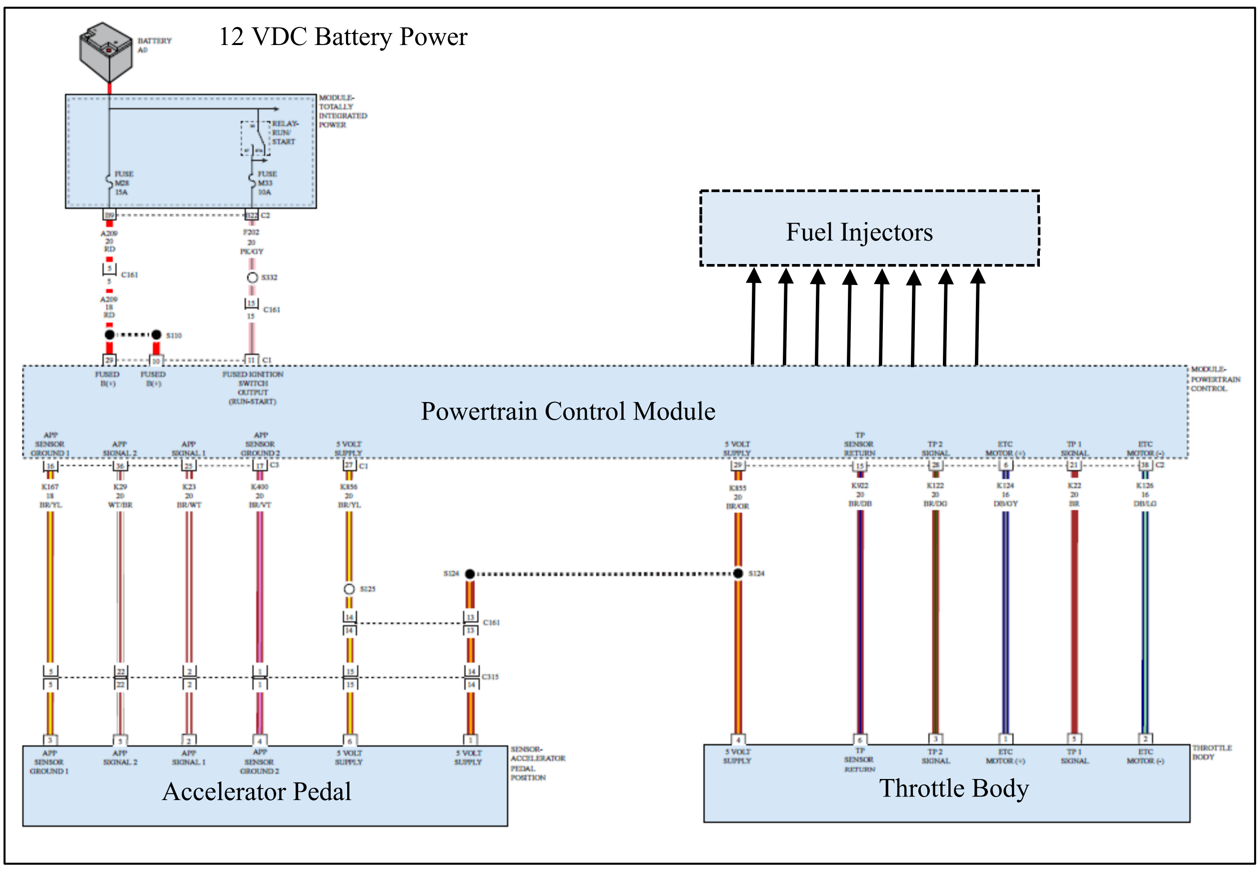

Figure 1- Block diagram of the Electronic Throttle Control System.

The 2011 Jeep Grand Cherokee generates Diagnostic Trouble Codes ("DTCs") to alert the driver to any issues with the vehicle and to assist a repair technician when diagnosing and repairing the vehicle. When a DTC is set, the vehicle operational mode is appropriately adjusted to protect the driver from potentially hazardous performance. There are design performance ranges for each system, including the ETC system, which is part of the overall engine management system. If the ETC system performs outside of design limits, one or more DTCs are set and stored in the PCM

memory. The DTC causes the PCM to safely adjust engine performance and activates a relevant indicator lamp in the instrument cluster that remains illuminated until the issue is remedied.

Figure 2 shows a list of ETC related DTCs for the 2011 Jeep Grand Cherokee. These DTCs cover numerous potential mechanical, electrical, and electro-mechanical issues that are reported by the ETC system if an issue arises. As noted above, the Manley vehicle had the throttle body cleaned during its maintenance history. Soot or debris on and/or around the throttle valve does not affect the function of the throttle position sensors. Accordingly, the PCM would still receive reliable and accurate TPS signals to use for engine management and ETC control. If the throttle valve somehow became stuck or unable to open/close for any reason, including soot or debris build-up, the diagnostic system would detect and mitigate the situation such that no unintended acceleration would occur.[1] Furthermore, this condition would not affect braking effectiveness.

DTC code	Description
P0121	Throttle Position Sensor 1 Performance
P0122	Throttle Position Sensor 1 Circuit Low
P0123	Throttle Position Sensor 1 Circuit High
P0122	Throttle Position Sensor 2 Circuit Low
P0122	Throttle Position Sensor 2 Circuit High
P2100	Electronic Throttle Control Motor Circuit
P2101	Electronic Throttle Control Motor Performance
P2107	Electronic Throttle Control Module Processor
P2110	Electronic Throttle Control-Forced Limited RPM
P2111	Electronic Throttle Control- Unable To Close
P2112	Electronic Throttle Control- Unable To Open
P2115	Accelerator Pedal Position Sensor 1 Minimum Stop Performance
P2116	Accelerator Pedal Position Sensor 2 Minimum Stop Performance
P2118	Electronic Throttle Control Motor Current Performance-Bank 1
P2122	Accelerator Pedal Position Sensor 1 Circuit Low
P2123	Accelerator Pedal Position Sensor 1 Circuit High
P2127	Accelerator Pedal Position Sensor 2 Circuit Low
P2128	Accelerator Pedal Position Sensor 2 Circuit High
P2135	Throttle Position Sensor 1/2 Correlation
P2138	Accelerator Pedal Position Sensor 1/2 Correlation
P2167	Accelerator Pedal Position Sensor 1 Maximum Stop Performance
P2172	High Airflow/Vacuum Leak Detected(Instantaneous Accumulation)
P2173	High Airflow/Vacuum Leak Detected(Slow Accumulation)
P2175	Low Airflow/Restriction(Slow Accumulation)

Figure 2 – Partial List of DTCs for the 2011 Jeep Grand Cherokee Engine Management System.

The two most common alleged reasons for unintended acceleration (neither of which have been demonstrated for the subject 2011 Jeep Grand Cherokee) are described below.

[1] See DTC P2111, Electronic Throttle Control – Unable To Close and DTC P2112, Electronic Throttle Control – Unable To Open, listed in Figure 2.

First, if a 2011 Jeep Grand Cherokee actually accelerated without the accelerator pedal being pressed,[2] both accelerator pedal position sensors would have to simultaneously malfunction and provide accelerator pedal signals that correlated with applying the accelerator pedal, instead of signals indicative of the actual pedal position. Each malfunctioning pedal sensor voltage would have to stay within a specified range for the duration of the event; otherwise, the diagnostic system would detect the issue and mitigate the risk of unintended vehicle acceleration. For a given accelerator pedal position between "idle" and "floored,"[3] each pedal sensor has a unique value that must correlate with the other or a DTC will be set. No APPS related DTCs were found in the Manley vehicle, which means that if the APPS somehow experienced simultaneous APPS faults (one for each APPS sensor), they did not leave evidence, which is simply not plausible.

The DTCs listed in Figure 2 show the extent and robustness of the ETC diagnostic system. They show that if one or more of four sensors (two pedal, two throttle) are inconsistent with each other, or if the throttle valve motor malfunctions, a DTC will be set and fail-safe engine operation (reduced output power) will occur. In summary, a combination of accelerator pedal position and/or throttle valve position sensor malfunctions leading to unintended acceleration, while leaving no evidence, has never been demonstrated in the real-world for any modern ETC-equipped vehicle, including the 2011 Jeep Grand Cherokee.

Second, if an alleged "glitch" actually occurred in the ETC system software that somehow misinterpreted the accelerator pedal or throttle valve position signals, or any other system input, to cause unintended acceleration, then that same software would have to perform flawlessly in every other respect. That is, fuel injector signals, air flow sensor data, camshaft and crankshaft position sensor data, exhaust O_2 sensor data, brake switch status, and fuel pump control signals among others would have to perform to specification and be interpreted and used error-free by the same software that selectively malfunctioned. Otherwise, the engine would not operate correctly. The idea that a software fault like this occurs in the real-world is without technical merit, as explained by the Office of Defects Investigation, a division of the National Highway Transportation Safety Administration ("NHTSA"), in the 2015 denial of a petition for a defect investigation into unintended vehicle surging (DP14-003).

NHTSA Denial DP14-003 identifies the following three important points related to allegations about software defects:

- No specific software defect is identified;
- The effect(s) of the alleged software defect have not been reproduced;
- The alleged software defect is untestable.

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[2] In some instances, drivers who claim to have experienced an unintended acceleration, even while pressing the brake pedal, actually were pressing the accelerator pedal. There have been several studies that confirm pedal misapplication. See, for example:

- Richard A. Schmidt and Douglas E. Young, "Cars gone wild: the major contributor to unintended acceleration in automobiles is pedal error", Frontiers in Psychology 1:209
- Kathy H. Lococo, Loren Staplin, Carol A. Martell, and Kathy J. Sifrit, "Pedal Application Errors," NHTSA DOT HS 811 597, March 2012
- Jeya Padmanaban, Matthew Fitzgerald, Joseph Marsh, "Pedal Misapplication: Crash Characteristics and Contributing Factors", SAE 2013-01-0446.

[3] Traditionally, "idle" means the accelerator pedal is not pressed, while "floored" means the accelerator pedal is fully pressed to the floor.

These points also apply to the plaintiff's expert's speculative conclusions in the Manley case.

The ODI report "sees no factual basis for assigning any level of probability" to the proposed software defects. Furthermore, in response to the allegation that engine management and ETC software is too complex to test and would take too many tests to find or evaluate the alleged defect, ODI states that this reasoning "precludes any scientific evaluation of the validity of such theories."

I agree with the ODI's conclusions. In order to have any opinion to a reasonable degree of scientific certainty, an investigator must show evidence, test repeatability, and rule out all other reasonable explanation(s).

<u>Exemplar Vehicle Inspection</u>

An exemplar vehicle inspection was performed at BRC, in San Antonio, Texas. The vehicle inspected was a 2011 Jeep Grand Cherokee, equipped with the 5.7L V8 ETC system, with VIN 1J4RR6GT5BC727288. The Carfax report for this vehicle shows that the service-related work performed has been standard scheduled maintenance. There is one incomplete recall for a fuel pump relay failure, which in some cases can cause a stall condition if the vehicle is running or a no-start condition if not running. Figure 3 shows photographs of the exemplar vehicle.

Figure 3 – Photographs of the exemplar vehicle evaluated for comparison to the subject vehicle. (P3221276.JPG and P3221275.JPG)

As with the subject vehicle inspection and testing, the exemplar vehicle analysis utilized a breakout box[4] to test the integrity of the electrical connections between the PCM and relevant ETC circuits and components. These circuits and components include: power and ground, accelerator pedal position sensors, throttle position sensors, throttle valve motor, and the brake/stop lamp switch.

[4] The breakout box consists of an exemplar PCM connector (so it can securely connect to the vehicle-side PCM wire harness connector) with wires between each relevant connector pin and a box with access points, as shown in Figure 4. Use of a breakout box facilitates non-destructive electrical measurements.

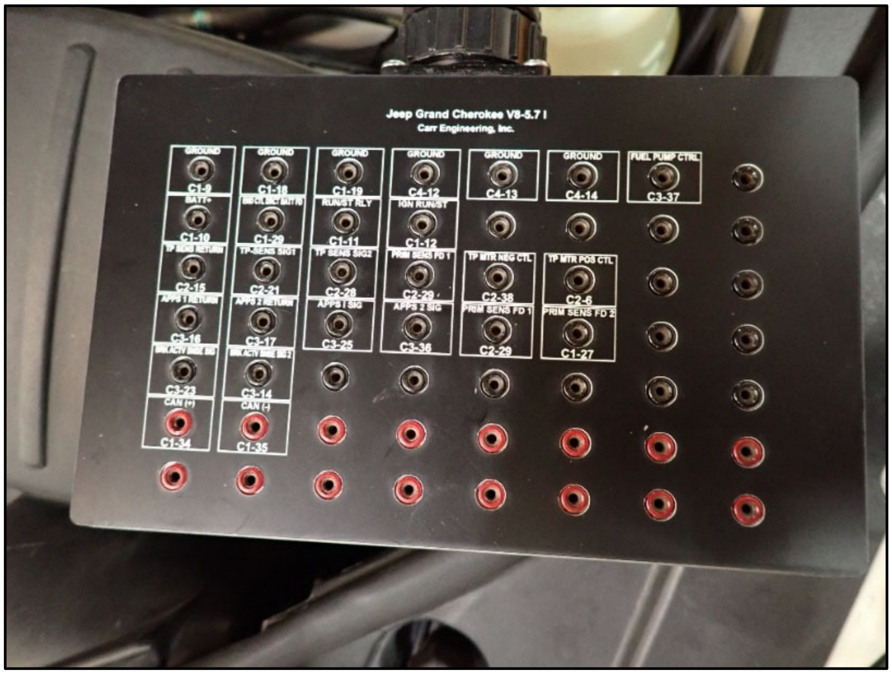

Figure 4 – Photograph of the breakout box used to perform electrical measurements. (P3231305.JPG)

Figure 5 shows the location in the engine compartment where the PCM is located.

Figure 5 – Photograph of the PCM in the front passenger-side area of the engine compartment. The PCM has red tabs on the connectors. (P3221296.JPG)

Inspection of the accelerator pedal found no issues with the idle and floored positions or the driver footwell area. The accelerator pedal moved freely and smoothly, and efficiently returned to the idle or rest position when no force was applied. The breakout box was then connected to the vehicle by disconnecting the vehicle-side PCM wire harness connectors (from the PCM) and mating them to the breakout box connectors. Resistances of the APPS circuits in both the idle and floored positions were measured and recorded. Additional measurements showed no inadvertent electrical connections between the APPS circuits and B+ or B- (Ground).

Next, the APPS circuits were powered with a 5 VDC source and the APPS voltages were measured in the idle and floored positions. An accelerator pedal sweep was performed and both APPS signals changed smoothly and without gaps. The exemplar vehicle APPS test results were normal and within specification.

Evaluations of throttle position sensor ("TPS") and throttle valve motor circuits were performed similar to that of the APPS circuits. The resistances of the sensors and motor were measured and no inadvertent electrical connections to B+ or B- were observed. Figure 6 shows the throttle body and valve on the exemplar vehicle.

Figure 6 – Photograph showing the engine compartment with components removed for access to the throttle body. (P3231303.JPG)

The resistances between individual circuits were measured with the throttle body in the idle and wide-open throttle positions. The TPS circuits were powered with 5 VDC and the circuit voltages were measured for the idle and wide-open throttle positions. A voltage sweep was performed on

the throttle body assuring that the signals varied smoothly and without gaps. The test results for the exemplar vehicle TPS were within specification.

A visual inspection was performed on the brake pedal and switch to evaluate the position of the brake pedal and the general condition of the brake pedal/floor pan area. The brake pedal was then exercised to make sure that there was no sticking or binding. No issues were found.

The electrical performance of the brake/stop lamp switch was tested, first measuring its continuity to the PCM and then by removing the switch for bench testing, which confirmed that it functioned properly. In summary, no issues were found with the brake/stop lamp switch or pedal assembly.

Subject Vehicle Inspection

On February 10, 2021, in Leonard, Texas, I inspected the subject 2011 Jeep Grand Cherokee with VIN 1JRR6GT9BC620745. This particular vehicle is equipped with a 5.7-liter V8 Hemi engine, an automatic transmission, and a four-wheel drive transfer case. The Carfax for the subject vehicle shows a listing of standard services being performed and one throttle body service. The service records reflect that in addition to standard scheduled maintenance, the throttle body assembly was serviced on two occasions. The throttle body assembly service is cleaning the throttle plate of dirt build up that may occur if the air filter is damaged, not present, or not replaced on schedule, if the vehicle is driven through regions with excessively dirty air, or from coking, which can build up over time due to exhaust gas recirculation. This is not part of the scheduled maintenance in the service document for the 2011 Jeep Grand Cherokee. Additionally, the vehicle service documents do not indicate that any DTCs were found related to the throttle body.

Figure 7 – Photograph 8434_a003.JPG shows a side view of the subject vehicle.

Visual inspection of the subject vehicle showed that the electronic digital odometer was unreadable due to crash damage, that the ORC (Occupant Restraint Controller) had been accessed and imaged, and there were no abnormal conditions observed when the braking system components were inspected. The brake fluid level was normal and the brake pedal firmness was observed to be

normal when the pedal was depressed. The master cylinder appeared to be in normal condition with the reservoir intact. There were no significant fluid leaks observed. The vehicle tires were also observed to have sufficient tread depth and were in good condition unless damaged in the crash.

The brake pedal and driver footwell area were inspected and found to be in normal condition and free of noticeable distortion or bends. The accelerator pedal supporting vehicle structure were found to be in normal condition, free of bends. The accelerator pedal moved smoothly when actuated by hand and quickly returned to the idle or rest position when no force was applied. The force required to operate the accelerator pedal was approximately six pounds when applied to the center of the pedal pad with a handheld force gauge as shown in Figure 8.

Figure 8 – Photograph 8434_a118.JPG showing the pedal force measurements taken with a handheld force meter.

The vehicle's electrical system was inspected and the battery was found to be in a state of deep discharge. The measured voltage was less than 1 VDC. The battery is located under the front passenger seat and the battery positive and negative cables at this location were intact, in good condition and free of corrosion.

Underhood fuses were checked and tested good either by continuity or visual inspection, with the only exception being fuse M4 (10A) "Trailer Tow," which was found to be open. This measurement is shown in Figure 9.

Figure 9 – Photograph 8434_a185.JPG showing the open Trailer Tow fuse testing.

The four connectors were removed from the PCM (Powertrain Control Module) and the breakout box was installed as shown in Figure 10.

Figure 10 – Photograph 8434_a171.JPG showing the breakout box connected to the PCM.

As discussed previously, the breakout box is a passive device that allows reliable measurements to be made of the vehicle's electrical system, including the accelerator pedal circuits, the throttle body circuits, CAN network, both poles of the brake pedal switch and power and ground circuits.

First, circuit resistance measurements similar to those described above for the exemplar vehicle were taken and recorded. For these measurements, every circuit is compared to every other circuit to detect circuit shorts and opens for each component. Active measurements are then made of certain components (APPS, TPS, and brake/stop lamp switch) by attaching a regulated, current limited, power supply to each component through the breakout box.

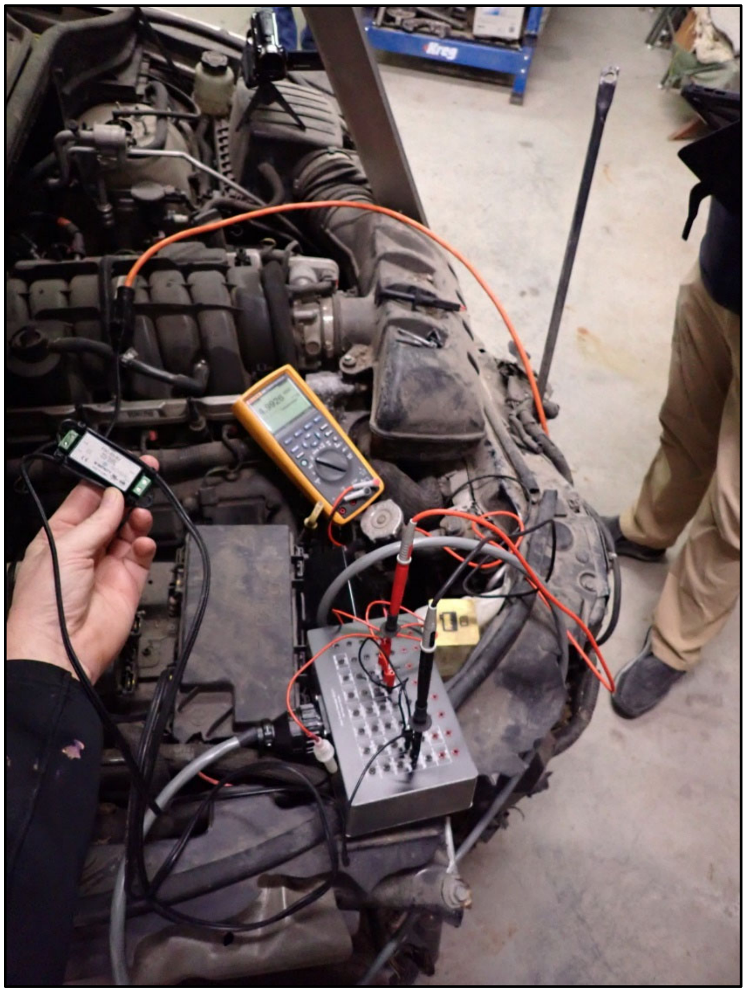

Figure 11 – Photo 8343_a188.JPG shows the regulated 5 VDC power supply used to energize the throttle valve and accelerator pedal position sensors during the subject vehicle inspection.

A separate breakout box was connected to the brake switch, which was then tested on the bench. A regulated power supply was connected to the brake switch through the breakout box and the switch was tested and found to be in good condition and functioned properly. In addition, the continuity of the normally open and the normally closed brake switch/stop lamp switch to the PCM were confirmed in the vehicle using the PCM breakout box.

All of the resistance and voltage measurements taken during the inspection were as per vehicle specifications, other than the open fuse mentioned earlier. These same resistance and voltage measurements are next compared to results from an exemplar or substantially similar vehicle.

Comparison of Subject and Exemplar Vehicle ETC System Electrical Parameters

Comparison of APPS voltage data for the subject and exemplar vehicles show excellent agreement, as shown in Figure 12. The data for both vehicles meets the specified values for both idle and floored pedal positions.

IDLE

Subject Vehicle - 1J4RR6GT9BC620745

Accelerator Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	APPS_RTN2 (C3-17)	APPS1 (C3-25)	APPS2 (C3-36)	FD1 (C2-29)	FD2 (C1-27)
APPS_RTN1 (C3-16)	0.0	-0.42	-0.23	-5.0	-5.0
APPS_RTN2 (C3-17)		-0.42	-0.23	-5.0	-5.0
APPS1 (C3-25)			0.20	-4.56	-4.57
APPS2 (C3-36)				-4.77	-4.77
FD1 (C2-29)					0.00

IDLE

Surrogate Vehicle - 1J4RR6GT5BC727288

Accelerator Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	APPS_RTN2 (C3-17)	APPS1 (C3-25)	APPS2 (C3-36)	FD1 (C2-29)	FD2 (C1-27)
APPS_RTN1 (C3-16)	0V	-0.414V	-0.215V	-4.99	-4.99
APPS_RTN2 (C3-17)		-0.414V	-0.215V	-4.99	-4.99
APPS1 (C3-25)			+0.20V	-4.57V	-4.57V
APPS2 (C3-36)				-4.77V	-4.77V
FD1 (C2-29)					0V

WOT

Accelerator Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	APPS_RTN2 (C3-17)	APPS1 (C3-25)	APPS2 (C3-36)	FD1 (C2-29)	FD2 (C1-27)
APPS_RTN1 (C3-16)	0.00	-4.59	-2.31	-4.99	-4.99
APPS_RTN2 (C3-17)		-4.59	-2.31	-4.99	-4.99
APPS1 (C3-25)			2.29	-0.40	-0.40
APPS2 (C3-36)				-2.69	-2.69
FD1 (C2-29)					0.00

WOT

Accelerator Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	APPS_RTN2 (C3-17)	APPS1 (C3-25)	APPS2 (C3-36)	FD1 (C2-29)	FD2 (C1-27)
APPS_RTN1 (C3-16)	0V	-4.60V	-2.31V	-4.99V	-4.99V
APPS_RTN2 (C3-17)		-4.60V	-2.31V	-4.99V	-4.99V
APPS1 (C3-25)			2.28V	-0.40V	-0.40V
APPS2 (C3-36)				-2.68V	-2.68V
FD1 (C2-29)					0V

Figure 12 – Comparison of acceleration pedal sensor voltages between the Subject and Exemplar vehicles.

Figure 13 shows the TPS voltage data comparison for the subject and exemplar vehicles. Measurements were taken with the throttle valve at the rest position and the wide-open throttle ("WOT") position. In each case the sensor signals were within specification.

IDLE

Subject Vehicle - 1J4RR6GT9BC620745

Throttle Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	TP1 (C2-21)	TP2 (C2-28)	FD1 (C2-29)	TPM- (C2-38)	TPM+ (C2-6)
TP RTN (C2-15)	-0.87	-4.13	-5.00	-0.09	-0.09
TP1 (C2-21)		-3.26	-4.13	-0.09	-0.09
TP2 (C2-28)			-0.87	-0.01	-0.01
FD1 (C2-29)				0.01	0.01
TPM- (C2-38)					0.00

IDLE

Surrogate Vehicle - 1J4RR6GT5BC727288

Throttle Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	TP1 (C2-21)	TP2 (C2-28)	FD1 (C2-29)	TPM- (C2-38)	TPM+ (C2-6)
TP RTN (C2-15)	-0.861V	-4.154V	-5.00V	0V	0V
TP1 (C2-21)		-3.292V	-4.137V	0V	0V
TP2 (C2-28)			-0.884V	0V	0V
FD1 (C2-29)				0V	0V
TPM- (C2-38)					0V

WOT

Throttle Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	TP1 (C2-21)	TP2 (C2-28)	FD1 (C2-29)	TPM- (C2-38)	TPM+ (C2-6)
TP RTN (C2-15)	-0.478	~~[illegible]~~ -0.24	-5.00	~0.1	~0.1
TP1 (C2-21)		4.53	-0.23	~0.1	~0.1
TP2 (C2-28)			-4.26	~0.1	~0.1
FD1 (C2-29)				~0.1	0.0
TPM- (C2-38)					0.00

WOT

Throttle Position Sensor
Voltage Measurements

BLACK Probe

VOLTAGE	TP1 (C2-21)	TP2 (C2-28)	FD1 (C2-29)	TPM- (C2-38)	TPM+ (C2-6)
TP RTN (C2-15)	-4.763V	0.244V	-5.00V	0V	0V
TP1 (C2-21)		4.519V	0.234V	0V	0V
TP2 (C2-28)			-4.754V	0V	0V
FD1 (C2-29)				0V	0V
TPM- (C2-38)					0V

Figure 13 – Comparison of the TPS voltages at Idle and WOT for the Subject and Exemplar vehicles.

In summary, it has been shown that critical ETC components on the (post-crash) subject vehicle performed to specification. Measured results are in excellent agreement with data obtained from an undamaged exemplar vehicle. The subject vehicle's service history, inspection results, and no verifiable abnormal vehicle performance prior to the crash support that no scientific evidence has been presented to support plaintiff's allegations of unintended acceleration. In fact, the evidence supports that the Manley vehicle simply responded as designed to the driver's commands.

Discussion of Plaintiff's Expert's Allegations

Plaintiff's expert Stichter states in his report that none of the recalls on the subject vehicle are associated with the throttle body or the ETC system. This was confirmed and discussed previously in this report.

NHTSA Complaints

Plaintiff's expert Stichter discusses 15 NHTSA complaints about the 2011 Jeep Grand Cherokee that he claims are consistent with the circumstances in the Manley case. Only four of these complaints pertain to Jeep Grand Cherokee vehicles equipped with the 5.7L V8 ETC system. The remaining 11 pertain to a different engine and different throttle control system. The four relevant cases will be briefly discussed. For clarity, excerpts from the NHTSA database for the four relevant complaints is shown in Figure 14.

NHTSA ID	Model	Year	VIN	Date	Comments	Comments From Stichter Report	Engine (8th) T - 5.7L V8
11115077	GRAND CHEROKEE	2011	1J4RR6GT8BC	20180801	ON MULTIPLE OCCASIONS IN THE LAST FEW DAYS, THE BRAKES HAVE FAILED TO RESPOND (EXTREME FORCE IS NEEDED TO PUSH DOWN ON THE BRAKE PEDAL), WHICH DELAYS BRAKING TIME/DISTANCE SIGNIFICANTLY. THIS IS HAPPENING SPECIFICALLY WHEN TRYING TO DISENGAGE FROM CRUISE	On multiple occasions, extraordinary brake force was needed to slow the vehicle when cruise control was engaged.	5.7L V8
10594461	GRAND CHEROKEE	2011	1J4RR6GT6BC	20140528	EXPERIENCED UNINTENDED ACCELERATION, AT A STOP OR NEAR STOP WHEN PARKING. ALTHOUGH MY FOOT WAS ON THE BREAK, THE CAR LUNGED FORWARD AS IF THE ACCELERATOR HAD BEEN PUSHED ALL THE WAY DOWN, HITTING THE BACK OF A PARKED TRUCK VIOLENTLY. ALTHOUGH THE IMPACT	Vehicle experienced unintended acceleration at near a stop while parking. With driver's foot on brake, the car lunged forward as if the accelerator had been pressed all the way down.	5.7L V8
10553598	GRAND CHEROKEE	2011	1J4RR5GT4BC	20131124	THE FIRST 3 WEEKS I HAD THE VEHICLE THE ENGINE LIGHT KEPT COMING ON. I RETURNED TO THE LITHIA DEALERSHIP IN SANTA FE 3 TIMES TO HAVE IT CORRECTED. THEY ACCUSED ME OF FUELING THE CAR WITH THE ENGINE RUNNING. I DO NOT FUEL MY CARS WITH THE ENGINE RUNNING.	Vehicle experienced sudden unexplained acceleration.	5.7L V8
10457148	GRAND CHEROKEE	2011	1J4RRGT1BC4	20120502	WHILE BACKING UP A MODERATELY STEEP GRAVEL DRIVEWAY IN 4 LOW RANGE I APPLIED THE BRAKE AND SHIFTED THE VEHICLE FROM REVERSE (R) TO DRIVE (D) AND THE ENGINE IMMEDIATELY WENT TO ALMOST FULL THROTTLE FOR 2-3 SECONDS AND EVEN THOUGH I WAS PRESSING ON THE BRAKE	Driver shifted from reverse to drive and the engine immediately went to almost full throttle for 2-3 seconds while driver was pressing on brake pedal.	5.7L V8

Figure 14 – Excerpt of complaints from the NHTSA database (with plaintiff expert Stichter comments added) related to unintended acceleration in the 2011 Jeep Grand Cherokee vehicles equipped with a 5.7L V8.

Reviewing the comments for each complaint shows that none of the 5.7L V8 equipped vehicles' events are similar to the Manley event. Three of the four complaints (NHTSA ID No.'s 11115077, 10594461, 10457148) describe applying the brakes during various driving situations. As will be shown subsequently, the CDR Report shows the driver of the Manley vehicle did not press the brake prior to impact, and was actually applying the accelerator pedal. The CDR Report for the Manley vehicle also shows the cruise control system was off and not active at the time of the crash. After drilling down further into the comments for the remaining complaint (NHTSA ID No. 10553598), I found a description of the check engine light coming on and the transmission downshifting while merging onto the highway. This is not similar to the subject crash in any way.

As far as I know, Stichter has not inspected any of these vehicles. As such, it is not appropriate to conclude anything scientific about a NHTSA complaint until an investigator has inspected and tested each vehicle, including service history review and the details of the alleged event. Also, for events resulting in a crash, a CDR readout could contain useful technical information, as in the Manley case. Such an approach would enable an investigator to rule out or not rule out whether the vehicle, the driver, the environment, or some other factor was responsible for the reported event.

In addition to pedal misapplication and driver error/inattention, which are both plausible explanations for reported unintended acceleration events, drivers frequently do not understand how certain vehicle systems operate. An example of this is Adaptive Cruise Control ("ACC"), a feature present on the Manley 2011 Jeep Grand Cherokee. These possible explanations for unintended acceleration merit discussion for completeness. They also provide possible explanations for the limited number of NHTSA complaints about unintended acceleration events for the 2011 Jeep Grand Cherokee referenced by Stichter.

Some reports of unintended acceleration discuss the vehicle speed inexplicably increasing while driving. This would feel the same as cruise control re-engaging without immediate driver input. A plausible explanation for this is related to Adaptive Cruise Control. When the ACC sensor detects a vehicle ahead, it will apply limited braking and/or reduce engine power automatically to maintain a pre-set following distance and match the speed of the vehicle ahead. So, if a 2011 Jeep Grand Cherokee is moving at, say, 65 mph, with no vehicle in front of it, the ACC will maintain 65 mph. If a vehicle moving at, say, 55 mph, pulls in front of this 2011 Jeep Grand Cherokee at a distance equal to or less than the pre-set distance, the ACC will slow the 2011 Jeep Grand Cherokee to 55 mph without driver input. If the slower vehicle then moves to an adjacent lane, and the 2011 Jeep Grand Cherokee's lane is clear, the ACC will increase the 2011 Jeep Grand Cherokee speed back to 65 mph, without any driver input, assuming the 2011 Jeep Grand Cherokee driver has not pressed the brake or otherwise disengaged the ACC. Accordingly, the 2011 Jeep Grand Cherokee Owner's Manual warns against leaving the ACC system on except while in use. An excerpt from the Owner's Manual of the Warning is shown in Figure 15.

WARNING!
Leaving the Adaptive Cruise Control (ACC) system on when not in use is dangerous. You could accidentally set the system or cause it to go faster than you want. You could lose control and have a collision. Always leave the system off when you are not using it.

Figure 15 – Adaptive cruise control Warning excerpted from the 2011 Jeep Grand Cherokee Owner's Manual.

Manley Vehicle CDR Report

The CDR report from the February 16, 2017 Manley crash shows that two events were recorded. The pre-crash data show that prior to the first recorded event, the brake pedal was not applied, as represented by the red line at "0" in Figure 16. This chart also shows that Mr. Manley was applying the accelerator pedal as shown by the blue line in Figure 16. The CDR pre-crash data represent a reliable, objective record of driver actions in the seconds before a crash.

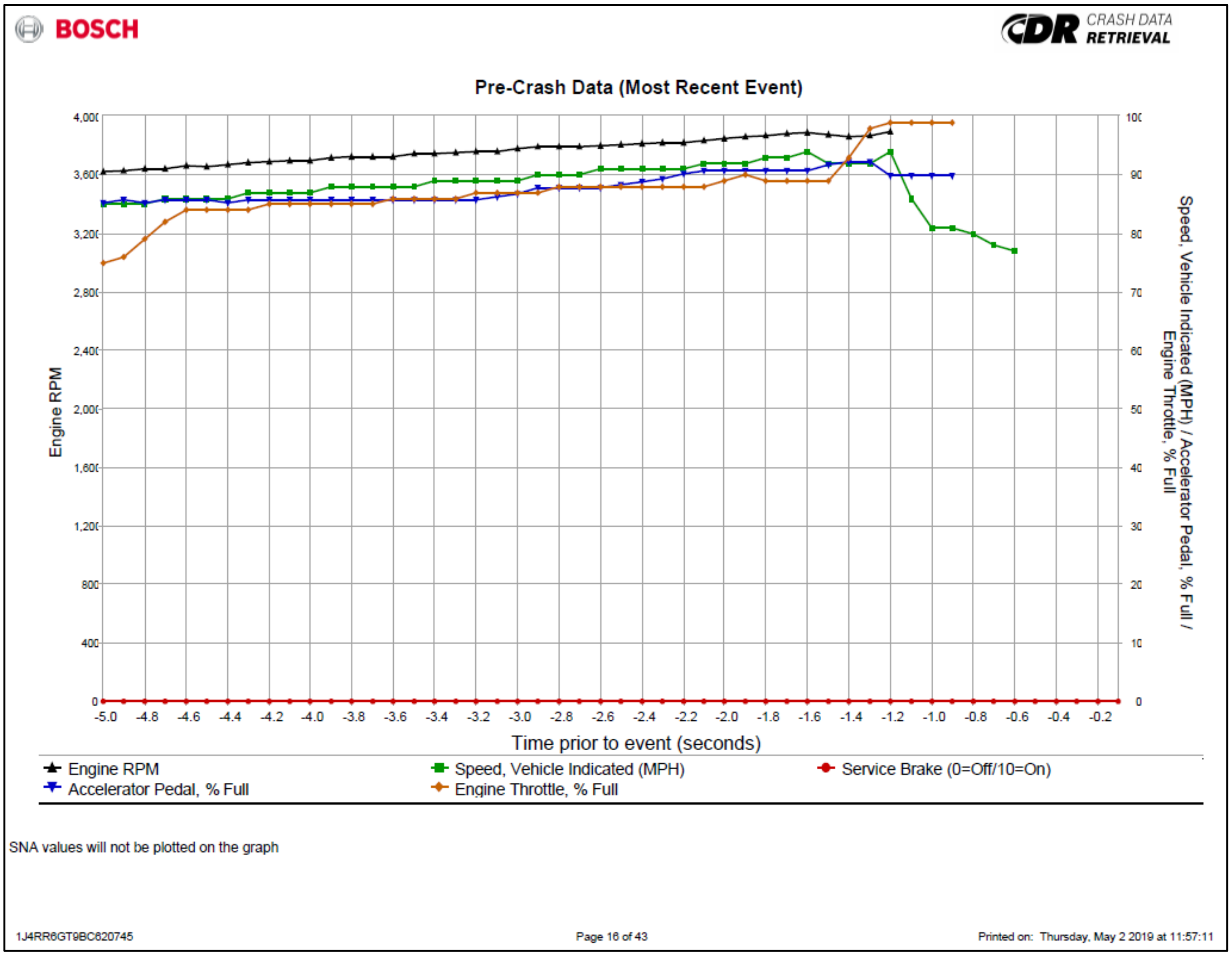

Figure 16 – Pre-Crash Data from the CDR Crash Retrieval file for the subject vehicle (VIN 1J4RR6GT9BC620745).

<u>Opinions</u>

Based on my education, training, experience, review of documents, reports, inspections, testing, and publicly available literature, my conclusions to a reasonable degree of engineering certainty regarding this matter are as follows:

- There are no defects in the 2011 Jeep Grand Cherokee 5.7L V8 Electronic Throttle Control (ETC) system.

- The 2011 Jeep Grand Cherokee 5.7L V8 Electronic Throttle Control (ETC) system is state of the art for the 2011 model year time frame.

- None of the control signals (Accelerator Pedal Position Sensors, Throttle Position Sensors, Throttle Motor) for the 2011 Jeep Grand Cherokee 5.7L V8 Electronic Throttle Control System travel through the Totally Integrated Power Module.

- The subject 2011 Jeep Grand Cherokee vehicle service documents do not indicate that any Diagnostic Trouble Codes (DTCs) were found relating to the throttle body. The throttle body was cleaned. Neither the throttle body nor related components were replaced.

- Inspection and testing of the subject 2011 Jeep Grand Cherokee's electrical system including, the Electronic Throttle Control (ETC) system confirmed they performed to specification; there is no evidence of any defect in the ETC system in the subject 2011 Jeep Grand Cherokee.

- The NHTSA vehicle complaints referenced in plaintiff's expert's report are not scientific evidence of a defect in the 2011 Jeep Grand Cherokee Electronic Throttle Control (ETC) system. No other scientific evidence (vehicle inspection results, service history review, ETC testing, CDR report, etc.) has been presented for any of these vehicles. Furthermore, there are other plausible explanations for these complaints that cannot be ruled out, including pedal misapplication, lack of understanding of a vehicle function or feature, and/or driver inattention.

- On February 16, 2017, the subject 2011 Jeep Grand Cherokee responded to the driver's commands and performed as designed, as confirmed by the CDR report. The cause of the subject crash was the driver, not the vehicle.

The analyses and opinions expressed in this report are based on information currently available, and they may be supplemented if further data, information, or analyses become available. Carr Engineering, Inc. charges $445 per hour for my time. Please contact me if you have any questions concerning the above findings.

Thomas G. Livernois

Thomas G. Livernois, Ph.D., P.E.
Carr Engineering, Inc.

Appendix 1

Materials Reviewed

- Manley - Retention Ltr to Tom Livernois
- Manley - Doc 1 Plaintiff's Original Complaint
- Manley - Doc 13 Plaintiffs First Amended Complaint
- Manley - Doc 26 Order granting Tracy Withdrawal
- Manley - Doc 34 Second Amended Scheduling Order
- Manley - FCA's Initial disclosures
- Manley - FCA's Responses to Plaintiff's First RFP
- Manley - FCA's Responses to Plaintiff's Second RFPs
- Manley - Plaintiffs' Response to FCA's RFPs 10.11.19
- Manley - Paul Manley's Response to FCA's ROGs 10.11.19
- Manley - Estate's Response to FCA's ROGs 10.11.19
- Manley - Plaintiffs' Initial Disclosures 5.3.19
- FCA Production
    - Production Logs
    - Production 1 [FCAUS-MANLEY-000001-014355]
    - Production 2 [FCAUS-MANLEY-014356-019568]
- Manley - TSBs
- Manley – Plaintiffs' Document Production 10.11.19
    - RFP 1 – Harold Manley BC, Harold Manley DL, Paul Manley DL
    - RFP 2 – Harold and Rosanna ML
    - RFP 5 – Employment Records Release
    - RFP 6 – Request for Copy of Tax Return
    - RFP 7 – Authorization to Disclose Protected Health Information
    - RFP 8 – Authorization to use and/or Disclose… Protected Health Information
    - RFP 9 – Harold Manley Death Certificate
    - RFP 10 – Medical Examiners Report and Photographs
    - RFP 11 – Funeral Home Records
    - RFP 12 & 13 – Last Will and Testament
    - RFP 16 – Jeep Service Records
    - RFP 24, 26 & 27 – Allstate Records
- M18 Dealer - Brake Control Wire Harness
- P14 Dealer - Brake Booster
- P54 Dealer - Fuel Pump Relay
- R71 Dealer - Sun Visor Wiring
- T59 Dealer - Brake Booster Water Shield
- Manley - Death Certificate
- Manley - Paul Randall Manley CDH
- 28038.004 Bonham Police Department CDs
    - 01 CD 911 Recording1
    - 02 CD 911 Recording 2
    - 03 DVD Video Footage
    - 04 CD Crime Scene Photos
    - 05 CD Medical Examiner Photos

06 CD Aerial Drone Photos

- 28038.004 - Manley - Bonham Police Department Records
- 28039.004 - Manley - Bonham Fire Department - Ambulance & EMS
- PAR from Plaintiff
- Manley - Medical Examiner's Inspection Report
- Manley - Traffic Citation
- CDR Report for 1J4RR6GT9BC620745_ACM
- Manley - 2019 CARFAX Report
- Manley - Vehicle Docs Produced by Plaintiff on 2017-09-07
- John Hinger Vehicle Inspection Photographs 2019 0516
- Lisa Gwin Vehicle Inspection Photographs 2020 1021
- Greg Stephens - Vehicle Inspection Photograph Binder
- Manley - Plaintiff's Expert Reports and Disclosure – Supplemental
  - Michael Markushewski 2020 1211
  - Daniel Wolfe 2020 1211
  - Andrew Rentschler 2020 1211
  - Michael Stichter 2020 1211
- Plaintiff's Expert Materials
  - Crashworthiness and Biomechanics
  - Reconstruction
  - Throttle Body
- Vehicle Inspection Notes and Photographs 2021 0210
- Exemplar Vehicle Inspection Notes and Photographs 2021 0323
- 2011 Grand Cherokee Service Documents
- NHTSA Denial DP14-003
- Richard A. Schmidt and Douglas E. Young, "Cars gone wild: the major contributor to unintended acceleration in automobiles is pedal error", Frontiers in Psychology 1:209.
- Kathy H. Lococo, Loren Staplin, Carol A. Martell, and Kathy J. Sifrit, "Pedal Application Errors", NHTSA DOT HS 811 597, March 2012.
- Jeya Padmanaban, Matthew Fitzgerald, Joseph Marsh, "Pedal Misapplication: Crash Characteristics and Contributing Factors," SAE 2013-01-0446.

Appendix 2

Thomas G. Livernois Ph.D., P.E.

Curriculum Vitae and Testimony History

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Curriculum Vitae for Thomas G. Livernois Ph.D., P.E.

Education and Licensing

- Ph.D., Electrical Engineering, University of Michigan, Ann Arbor, 1991
- M.S., Electrical Engineering, Michigan State University, 1986
- B.S., Electrical Engineering, Michigan Technological University, 1984
- Registered Professional Engineer, Michigan, Arkansas, New York, Virginia

Specialized Professional Competencies

- Design and analysis of electrical and electronic systems, including automotive and commercial vehicle systems functionality in adverse environments. Specific vehicle system experience includes powertrain, chassis, and safety systems.
- Root cause analysis of thermal events in electric machinery, generators, distribution systems, appliances, and switch gear
- Electromagnetic compatibility analysis and mitigation
- Root cause analysis of structural electrical fires, origin and cause of vehicle fires
- Electrocution, power distribution faults, and arc flash events

Professional Experience and Qualifications

- Product Engineer, Power Distribution / Electronic Systems, Ford Motor Company, 1991 to 1994
- Product Engineer/Senior Engineer, Electrical/Electronic Systems Compatibility, Chrysler Corporation, 1995-1998
- Supervisor, Powertrain and Chassis Electronics, DaimlerChrysler, 1998 to 2000
- Executive Director, AGC America Inc., 2000 to 2003
- Owner/President, Physics Solutions, LLC, 2003
- Principal Engineer, Electrical and Semiconductors Practice, Exponent, 2003 to 2010
- Principal Engineer, Design Research Engineering, 2010 to 2019
- Principal Engineer, Carr Engineering, 2019 to present

Professional Memberships

- Member, Institute of Electrical and Electronic Engineers (IEEE)
- Member, SAE International
- Chair, SAE Odometer and Speedometer Committee

Recent Professional Development

- Introduction to NFPA 70, 2020 National Electrical Code, NTT, 2019
- Overview and Impact of the ISO 26262 Standard, SAE, 2019
- Introduction to Radar for Automotive Applications, SAE, 2018
- Keys to Creating a Cybersecurity Process from the J3061 Process Framework, SAE, 2016
- Cybersecurity: Introduction to Embedded System Exploitation, SAE, 2016
- Reconstruction and Analysis of Rollover Crashes of Light Vehicles, SAE, 2016
- Reconstruction and Analysis of Motorcycle Crashes, SAE, 2016
- FMEA for Robust Design, SAE, 2016
- Driver Distraction from Electronic Devices, SAE, 2016
- Fundamentals of Automotive All-Wheel Drive Systems, SAE, 2016
- The Scientific Method for Fire and Explosion Investigations, IAAI, 2014

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THOMAS G. LIVERNOIS PH.D, P.E.

Publications

- Arora A, Medora NK, Livernois TG, Swart J, "Safety of Lithium-Ion Batteries for Hybrid Electric Vehicles," Electric and Hybrid Vehicles, 2010, 18: 463-491
- Livernois, TG, "Electric and Magnetic Fields, Ions, Audible Noise, and Radio Noise", New York Regional Interconnection Study, November 2007
- Livernois TG, "On the Reciprocity Factor for Shielded Microstrip," Microwave and Optical Technology Letters 1995; 10(6):327–330, December.
- Livernois TG, "Characterization of Dissipative Losses in Microwave Circuits," Microwave and Optical Technology Letters 1994; 7(15):687–689, October.
- Livernois TG, East JR, "Analysis of a Microstrip Step Discontinuity Fabricated on a Metal-Insulator-Semiconductor (MIS) Substrate," Microwave and Optical Technology Letters 1992; 5(13):661-666, December.
- Livernois TG, Nyquist DP, Cloud MJ, "Scattering Effects in the Dielectric Slab Waveguide Due to Electrically Dissipative and Active Discontinuities," IEEE Transactions on Microwave Theory and Techniques 1991; 39(3):579–583, March.
- Livernois TG, Katehi PB, "A Simple Method for Characterizing Planar Transmission Line Discontinuities on Dissipative Substrates," IEEE Transactions on Microwave Theory and Techniques 1991; 39(2):368–370, February.
- Livernois TG, Katehi PB, "Characteristic Impedance and Transverse Field Distribution in MIS Microstrip," IEEE Transactions on Microwave Theory and Techniques 1990; 38(11):1740–1743, November.
- Livernois TG, Katehi PB. "Generalized Method for Deriving the Space-Domain Green's Function in a Shielded, Multilayer Substrate Structure, with Applications to MIS Slow Wave Transmission Lines," IEEE Transactions on Microwave Theory and Techniques 1989; 37(11):1761–1767, November.
- Livernois TG, Nyquist DP. "Integral Equation Formulation for Scattering by Dielectric Discontinuities Along Open Boundary Waveguides," Journal of the Optical Society of America A 1987; 4(7):1289–1295, July.

Symposium Papers

- Medora, NK, Arora, A, Livernois, TG, "Series Arcing Faults in Electrical Transportation Systems," SAE 2010-01-0036, April 2010

- Arora A, Medora N, Livernois T, “Circuit Protection Devices & Arc Fault Detection Schemes for Electrical Automotive Systems,” IEEE Symposium on Product Compliance Engineering, Austin, TX, October 20–22, 2008.
- Teune J, Livernois TG, “Correlation Between Automotive Electromagnetic Immunity Tests,” IEEE 1999 International Symposium on Electromagnetic Compatibility, Seattle, WA, August 2–6, 1999.
- Slattery K, Neal J. Livernois T, Smith S., “A Description of the Implementation of an Automated Conducted Emissions Chamber for Automotive Testing,” IEEE 1998 International Symposium on Electromagnetic Compatibility, Denver, CO, August 24–28, 1998.
- Schuster JW, Leubbers RJ, Livernois TG, “Application of the Recursive Convolution Technique to Modeling Lumped Circuit Elements in FDTD Simulations,” IEEE AP-S Symposium, Atlanta, June 21–26, 1998.
- Slattery KP, Monahan RL, Livernois TG, Smith SV, “Characterization of TEM Cell Discontinuities Due to Filtered DUT Test Harnesses,” IEEE EMC Symposium, Austin TX, August 18–22, 1997.
- Slattery KP, Livernois TG, “The Effects of I/O Wire Extensions on Measured RF Voltage,” IEEE EMC Symposium, Austin TX, August 18–22, 1997.
- Livernois TG, “Module Level Conducted Immunity Testing,” 1995 Society of Automotive Engineers EMC TopTec, Novi, MI, September 13–14, 1995.
- Livernois TG, “TEM Cell Radiated Immunity Testing,” 1995 Society of Automotive Engineers EMC TopTec, Novi, MI, September 13–14, 1995.
- Livernois TG, “Analysis and Design of Slow Wave Structures Using an Integral Equation Approach,” IEEE/MTT-S International Microwave Symposium, Long Beach, CA, June 12–16, 1989.

Speaking Engagements

- Autoline with John McElroy, Episode 1622, “Highly Charged”, May 25, 2012
- Product Liability Hot Topics Seminar for Defense Counsel, “Collision Avoidance Technology – New Technology Bringing A Host of New Claims”, Troy, Michigan, September 2009.
- Lotusphere 1997 – Pool of Knowledge, Engineering Book of Knowledge (EBOK), Orlando, Florida, January 27-30, 1997

Doctoral Thesis

- Livernois TG, “Numerical and Experimental Analysis of Metal-Insulator-Semiconductor Microstrip Structures,” The University of Michigan, Ann Arbor, Michigan, 1991.

Legal Testimony of Thomas G. Livernois, Ph.D., P.E. as of April 2021
(Bill Rate: $445 per hour)

Case Name	Date of Testimony		State/ Country	Court	Case No.
	Deposition	Trial/Hearing			
Hartley v. Navistar	Jun-2017		AL	Circuit Court for Macon County, Alabama	CV-2015-900151
Smith, Keith v. GM	Jun-2017		LA	United States District Court, Western District of Louisiana, Monroe Division	3:15-CV-2473
Wolf v. Daimler AG	Jul-2017		CA	Superior Court of the State of California, County of Sonoma	SCV-251845
Dodson v. GM	Jul-2017		NY	United States District Court, Southern District of New York	15-cv-08324
People v. Kesse (Cook County Consulting)		Jul-2017	IL	Circuit Court of Cook County	12CR-18667
Taber v. Ford	Jan-2018		MO	United States District Court, Western District of Missouri, Western Division	4:16-cv-00162-SWH
Panarello v. FCA US LLC	Feb-2018		FL	Circuit Court of the 15th Judicial Circuit in and for Palm Beach County Florida	502016CA007383XXXX MB DIV. AA
Dean v. Honda	Mar-2018		MO	United States District Court for the Western District of Missouri	6:17-CV-03069-DPR
General Motors LLC Ignition Switch Litigation Economic Loss	Apr-2018		NY	United States District Court Southern District of New York	14-MD-2543 (JMF) 14-MC-2563 (JMF)
Weams v. FCA US LLC	Jun-2018		LA	United States District Court Middle District of Louisiana	3:17-cv-4
Timmons v. VWGoA	Jun-2018		GA	United States District Court for the Northern District of Georgia, Atlanta Division	1:16-cv-0195
Santiago v. CNH Industrial	Jul-2018		TX	United States District Court for the Southern District of Texas, Corpus Christi Division	2:16-cv-00473
FCA US LLC v. Android Industries	Nov-2018		MI	Circuit Court for the County of Oakland, State of Michigan	2016-155579-CB
Chaides, Guillermo v. VWGoA	Apr-2019		AZ	Superior Court of the State of Arizona in and for the County of Maricopa	CV2017-001815
FCA US LLC v. Android Industries	May-2019		MI	Circuit Court for the County of Oakland, State of Michigan	2016-155579-CB
FCA US LLC v. Android Industries		Aug-2019	MI	Circuit Court for the County of Oakland, State of Michigan	2016-155579-CB
Richards v. FCA	Sep-2019		MI	State of Minnesoto County of St. Louis District Court 6th Judicial District	69DU-CV-18-247
Landis+Gyr Technology, Inc. et. al. v. Cooper Bussmann, LLC	Oct-2019		GA	Superior Court of Gwinnett County - State of Georgia	18-A00024-3
Goodrich v. Power Products	Feb-2020		SC	State of South Carolina County of Spartanburg, Court of Common Pleas	2017-CP-42-03271
Aberin v. American Honda Motor Company, Inc.	Jul-2020		CA	United States District Court, Northern District of California	3:16-cv-04384-JST
Estate of Gabriel Miranda v. Navistar, Inc. et al	Oct-2020			United States District Court, Southern District of Texas, McAllen Division	7:18-cv-00353
Partaker v. Hyundai	Jan-2021			Superior Court of the State of California, County of Orange	30-2018-01033589-CU-PL-CJC
Partaker v. Hyundai		Mar-2021		Superior Court of the State of California, County of Orange	30-2018-01033589-CU-PL-CJC

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Schedule of Fees

Carr Engineering, Inc. is a consulting firm that provides professional services in the fields of accident reconstruction, mechanical design, and risk analysis. The usual method by which its bills to clients are determined is by charging a fee for the time actually spent by its employees in completing an assignment and by charging for the actual amount of expenses incurred by the corporation in such assignments.

Professional fees vary for the employees. The present hourly rate by employee and employee classification is as follows:

Principal Engineers		
	James Walker, Jr.	$595
	Thomas Livernois	$445
	Eldon Leaphart	$395
	Hugh Mauldin	$395
	Robert Rucoba	$395
	Gerald Corwin	$395
Senior Engineers		
	Dan Barnes	$270
	Jennifer Crimeni	$270
	Amanda Duran	$270
	Michael Johnston	$270
	Steven Kent	$270
	Aaron Osterhout	$270
Engineering Assistants		
	All	$185
Technical Assistants		
	All	$125

In general, most cases require two engineers for complete data gathering in the field for vehicle and/or scene inspections. There is no premium charge made for extra hours, weekend work, or holiday work. There are no premium charges made for depositions, trial testimony, or other such events.

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